

DEPARTMENT OF THE ARMY
Missouri River Division, Corps of Engineers
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MRD-R 1110-2-12

MRDED-C

Regulation
No. 1110-2-12

1 August 1984

Engineering and Design
FOUNDATION GROUTING

1. Purpose. This regulation establishes policy and guidance for quality management of foundation grouting.
2. Applicability. This regulation applies to the Missouri River Division and its Districts.
3. References.
 - a. EM 1110-2-3506 (Grouting Technology)
 - b. ER 1180-1-6 (Construction Quality Management)
 - c. EM 1110-2-3504 (Chemical Grouting)
4. Government Quality Assurance. The primary requirement is to obtain quality construction of the grout curtain or foundation treatment as required by reference 3b. To obtain the desired quality, the grouting shall be performed as outlined in reference 3a. Particular attention should be given to the quality of the personnel assigned to the grouting operations. They shall be experienced geotechnical personnel with adequate grouting experience to demonstrate their ability to direct and supervise grouting operations. If a District lacks such proven capabilities, then experienced personnel should be obtained from other sources.
5. Technical Requirements. Additional requirements, supplementary to the references, are as follows:
 - a. Check fineness of cement. All the cement should pass a 200 mesh screen.
 - b. Standard practice should include 2% to 5% (by weight of cement) of Sodium Bentonite in cement grout. A colloidal bentonite mixer shall be required to mix the bentonite and water, fully dispersing and hydrating the bentonite before adding it to the grout mixer. The bentonite must be hydrated before contact with either wet or dry cement to avoid replacement of sodium in the bentonite with calcium from the cement. Such replacement destroys desirable properties of the bentonite. A separate mixer is required because cement grout residue and hardened flakes of grout must be kept from contacting the bentonite until the bentonite is fully hydrated.
 - c. In pressure grouting, always obtain pressure readings at the point of injection into the hole.

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d. Water should not be used to drill through overburden or soil backfill. Flight augers or other dry drilling methods will be accepted. Drilling mud may be used with caution and under Corps geotechnical supervision. Casing should be used through all embankment materials when grouting through embankments.

e. Procedures for backfilling grout and exploratory holes are as follows. A tremie pipe should be placed and held to within 6 inches of the bottom of the hole until undiluted grout overflows at the collar of the hole. Then the tremie pipe should be withdrawn slowly (less than 40 ft./min.) and grout pumped continuously until the end of the tremie pipe is removed from the hole. Use 1:1 or stiffer grout with approximately 4% sodium bentonite for backfilling in rock foundations. Less rigid mixes with up to 50% bentonite may be used for backfilling holes in soil foundations and embankments. Refill the holes as often as necessary until each hole is completely filled with the grout.

f. The orientation of inclined grout holes must be based on the geology. They should intercept all known joint trends, major discontinuities and voids. Horizontal grout holes should be considered for grouting thin zones with potential permeability, which daylight in the excavation or abutments.

g. Rotary rather than percussion drilling equipment shall be used for drilling grout holes in or through shale. In harder rocks where percussion drilling is acceptable, water should be required for evacuating cuttings. Immediately upon completion of drilling each grout hole or stage, the hole should be flushed by circulating clear water from the bottom of the hole. Circulation should normally continue until the return drill water is clear.

h. Immediately before pressure grouting, the hole should be thoroughly washed with water under pressure and water pressure tested. In no case should pressures exceed the maximum allowable grouting pressure.

i. Grout curtains (except exploratory curtains) beneath embankments shall consist of multiple lines of grout holes in the upper zone.

j. Pressure release should be provided for upper zone grouting by an open hole, stand pipe or line. For deeper zones where higher pressures are allowed, a pressure release valve should be required.

k. See reference 3a for required records and reports relative to grout hole drilling, pressure testing and pressure washing, and grouting. In addition to drilling logs, pressure testing and washing data, and grouting logs, up-to-date geologic plans and profiles shall be maintained in the field showing drilling and grouting information in relation to the geology.

l. A maximum rate of injection of 3 cfm shall be specified. Also, specifications should clearly indicate that the rate of injection will be controlled by the government.

m. A high speed, colloidal, shear-type grout mixer shall be specified.

n. The need to grout and the design of grouting treatment should be based on thorough geologic evaluation of site investigations, engineering needs and economic considerations. The investigations should be designed to explore the full lateral and vertical extent of the proposed treatment. The assessment of leakage potential must consider average foundation permeabilities and geologic conditions, and also the likelihood of anomalous conditions which could cause serious problems. These conditions may be caused by faults and other geologic structures, solutioning, stress release and rebound, unconformities, depositional features and weathering.

o. Reference 3c contains guidance on chemical grouting. The use of chemical and micro fine cement grouts by themselves or in conjunction with cement grouting is applicable to foundation grouting. When these are contemplated, field tests should be performed during planning stages of the program and results evaluated prior to preparation of plans and specifications.

6. Contractual Considerations.

a. Where grouting is performed by contract between the Government and the grouting contractor, the type of contract and procedures for obtaining contract services should be selected after careful consideration. Because of the requirement to make changes during construction to meet conditions encountered and the requirement for government control of grouting work (reference a), the firm-fixed-price contract is very poorly suited for grouting. Other types of contracts should be considered. Service contracts are considered generally applicable for this type of work.

b. Where grouting is performed by a subcontractor as part of a general construction contract, payment for placing grout should be by the hour rather than cubic foot. Use of split bid items for grouting should be avoided.

c. Other contractual means that should be considered:

(1) Pre-qualification of bidders.

(2) Consideration of contractor innovation and proposals through response to a request for proposals.

(3) Thorough geotechnical exploration and full disclosure of geotechnical data in the contract (both factual and interpretive).

(4) Avoid use of exculpatory or disclaimer clauses.

(5) Establish procedures for making field decisions and resolving potential disputes expeditiously and at as low a level as possible. Government and Contractor personnel should function as a team to accomplish the work with the best possible schedule, quality and economy.

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7. Hired Labor. In the interest of dam safety, MRD Districts should maintain and use an in-house grouting capability for remedial grouting. Reference 3a (Chapter 12) authorizes the accomplishment of grouting programs with hired labor and Government-owned equipment, and also discusses the advantages of performing grouting work with hired labor. This capability should be used when required for rapid response in urgent situations and also, at any time when greater economy can be achieved.

FOR THE COMMANDER:

/s/

LEE W. TUCKER

Colonel, Corps of Engineers

Deputy Commander

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